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**AFPTEF REPORT NO. 96-R-02  
AFPTEF PROJECT NO. 93-P-108**

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**Joint STARS  
RTMM Carrying Case**

**AFMC LSO/LOP  
AIR FORCE PACKAGING TECHNOLOGY AND ENGINEERING FACILITY  
WRIGHT PATTERSON AFB, OH 45433-5540  
January 1996**

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PROJECT NO. 93-P-108

TITLE: Joint STARS RTMM Carrying Case

## ABSTRACT

The Electronic System Center (ESC) at Hanscom AFB, MA requested the Air Force Packaging Technology and Engineering Facility (AFPTEF) assistance in designing a carrying case for the Joint STARS Program. The Joint STARS Program requires a carrying case to transport Remote Transportable Memory Modules (RTMM). The RTMM's are similar to a hard disk drive in a computer. Upon completion of a Joint STARS mission, the RTMM's are removed from the aircraft and transported to a base facility where the information collected on the RTMM is downloaded to a main computer.

The weight of the case and the number of RTMMs required per mission were the driving factors in the design. The case requirements are to be waterproof, one person carry, shock absorbent, house six RTMM's, and limited to a maximum weight of 42 pounds. MIL-C-4150, Military Specification, Cases, Transit and Storage, Waterproof and Water-Vaporproof was tailored to meet Joint STARS requirements.

After reviewing Joint STARS requirements, AFPTEF determined the best case design to be an off the shelf transit case. AFPTEF chose a water resistant, thin wall aluminum case. Case dimensions are 20.4 inches' length, 14.8 inches wide, and 10.2 inches' height. Wall thickness of 0.09 inches. The case has four cam-over-center latches, pressure relief valve, one handle, hinged top, stacking beads on the top and bottom to interlock stacked cases, and anti-static foam that houses six RTMM units. Maximum tare weight of the case is 15.5 pounds with a maximum gross weight of 42 pounds. External finish is bare aluminum.

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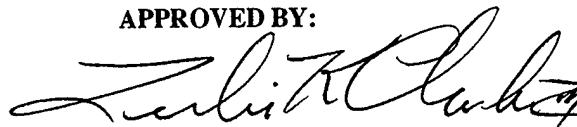
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## TABLE OF CONTENTS

	<u>PAGE</u>
Abstract.....	i
Table of Contents.....	ii
Introduction.....	1
Design.....	1
Testing.....	1
Conclusion.....	2
Test Report (Attachment 1).....	3

## APPENDICES

Appendix 1:	Photographs.....	19
Appendix 2:	Test Data.....	29
Appendix 3:	Test Plan.....	32
Appendix 4:	Distribution List.....	38
Appendix 5:	Report Documentation.....	44

## **INTRODUCTION:**

### BACKGROUND:

The Electronic System Center (ESC) at Hanscom AFB, MA requested the Air Force Packaging Technology and Engineering Facility (AFPTEF) assistance in designing a carrying case for the Joint STARS Program. The Joint STARS Program requires a carrying case to transport Remote Transportable Memory Modules (RTMM). The RTMM's are similar to a hard disk drive in a computer. Upon completion of a Joint STARS mission, the RTMM's are removed from the aircraft and transported to a base facility where the information collected on the RTMM is downloaded to a main computer.

### REQUIREMENTS:

The weight of the case and the number of RTMMs required per mission were the driving factors in the design. The case requirements are to be waterproof, one person carry, shock absorbent, house six RTMM's, and limited to a maximum weight of 42 pounds. MIL-C-4150, Military Specification, Cases, Transit and Storage, Waterproof and Water-Vaporproof was tailored to meet Joint STARS requirements.

## **DESIGN:**

### CONFIGURATION:

After reviewing Joint STARS requirements, AFPTEF determined the best case design to be an off the shelf transit case. AFPTEF chose a water resistant, thin wall aluminum case. Case dimensions are 20.4 inches' length, 14.8 inches wide, and 10.2 inches' height. Wall thickness of 0.09 inches. The case has four cam-over-center latches, pressure relief valve, one handle, hinged top, stacking beads on the top and bottom to interlock stacked cases, and anti-static foam that houses six RTMM units. Maximum tare weight of the case is 15.5 pounds with a maximum gross weight of 42 pounds. External finish is bare aluminum (see Appendix 1, figures 1 & 4).

## **TESTING:**

### TEST SPECIMEN:

AFPTEF procured two cases for testing (see Appendix 1, figure 1). Simulated test loads and foam inserts were designed in house by AFPTEF (see Appendix 1, figures 2, 3, & 4). Two configurations were tested. Configuration 1 housed eight RTMMs and configuration 2 housed six RTMMs.

### TEST PLAN:

The test plan was designed IAW MIL-C-4150 and Joint STARS requirements to qualify the case for transportation and storage in a world-wide environment. The test plan includes all test procedures, test equipment, and pass/fail performance criteria.

TEST REPORT:

See attachment 1 for complete test report.

**CONCLUSION:**

The prototype case passed all the tests with a few exceptions. The first configuration tested with eight RTMMs exceeded the weight limits of the handle and the human factors criteria of MIL-C-4150. This did not jeopardize the integrity of the case or the case's performance. However, the users decided to keep the case within human factor limits. Hence, the second configuration tested with six RTMMs corrected the deficiency.

Some other minor exceptions were the handle, latches, and pressure relief valve were not recessed within the envelope of the case. Since the case is being used to meet a specific requirement, these deficiencies were not critical and do not need to be corrected. A case could have been obtained to correct these problems. However, the weight of case would increase a considerable amount which would not meet the requirements of the specific need and not practical.

AFPTEF will continue to assist the Joint STARS program by procuring fourteen cases require to fulfill the Joint STARS needs. The case with cushion P/N 10-102481 is currently being stock listed by WR-ALC.

ATTACHMENT 1

TEST REPORT

APPROVED FOR PUBLIC RELEASE  
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PROJECT NUMBER: 94-P-114

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JOINT STARS REMOTE TRANSPORTABLE

MEMORY MODULE (RTMM) CASE

AFMC-LSO/LGTP  
5215 THURLOW ST BLDG 70  
WRIGHT-PATTERSON AFB OH 45433-5540

NOVEMBER 1994

#### NOTICE

When government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related government procurement operation, the United States Government thereby incurs no responsibility whatsoever, and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation or conveying any rights or permission to manufacture use or sell any patented invention that may in any way be related thereto. This report is not to be used in whole or part for advertising or sales purposes.

PROJECT: 94-P-114  
TITLE: JOINT STARS REMOTE TRANSPORTABLE MEMORY MODULES (RTMM)  
CASE

#### ABSTRACT

The objective of this test series was to determine if an off-the-shelf item would meet the transportation and storage requirements for the Joint Stars Remote Transportable Memory Module (RTMM) case.

The RTMM case is a sealed, reusable, aluminum case which conforms to MIL-C-4150J, Military Specification, Cases, Transit and Storage, Waterproof and Water-Vaporproof, Type I (waterproof), Style 1 (transit case), Class A (maximum gross weight up to 150 pounds), Variety HC (hinged closure). The cushioning system was engineered for physical and environmental protection for up to six RTMMs.

The test plan referenced MIL-C-4150J, MIL-STD-648A, MIL-STD-810E, and FED-STD-101C. The tests were performed at AFMC-LSO/LGTP, 5215 Thurlow St, Bldg 70, Wright-Patterson AFB OH 45433-5540.

MAN-HOURS: 140

PREPARED BY:

PUBLICATION DATE: 1 NOV 94

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DATABASE CLOSED OUT - 1 NOV 94



## TABLE OF CONTENTS

	<u>PAGE</u>
Abstract. . . . .	.5
Table of Contents . . . . .	.6
Introduction. . . . .	.7
Case Description. . . . .	.7
Test Procedure. . . . .	.8
Case Face Identification. . . . .	.8
 Test Sequences, Configuration - 1 . . . . .	 .8
a. Test Sequence 1, Examination of Product . . . . .	.8
b. Test Sequence 2, Quality Conformance Tests. . . . .	.9
 Performance Tests, Configuration - 1. . . . .	 .9
a. Test Sequence 3, Reusability. . . . .	.9
b. Test Sequence 4, Leak Test (Submersion) . . . . .	.9
c. Test Sequence 5, Concentrated Load Test . . . . .	.10
d. Test Sequence 6, Leak Test (Submersion) . . . . .	.10
e. Test Sequence 7A, Resonance Strength and Dwell Test. . . . .	.11
f. Test Sequence 7B, Repetitive Shock Test. . . . .	.12
g. Test Sequence 8, Leak Test (Submersion) . . . . .	.13
h. Test Sequence 9, Free-fall Drop Tests . . . . .	.14
i. Test Sequence 10, Leak Test (Submersion) . . . . .	.15
j. Test Sequence 11, Handling Test. . . . .	.15
k. Test Sequence 12, Rain Test. . . . .	.15
 Test Sequences, Configuration - 2 . . . . .	 .15
a. Test Sequence 2, Quality Conformance Tests. . . . .	.15
 Performance Tests, Configuration - 2. . . . .	 .16
a. Test Sequence 7A, Resonance Strength and Dwell Test. . . . .	.16
b. Test Sequence 7B, Repetitive Shock Test. . . . .	.17
c. Test Sequence 9, Free-fall Drop Tests . . . . .	.18

## APPENDICES

Appendix 1 - Photographs. . . . .	.19
Appendix 2 - Test Data. . . . .	.29
Appendix 3 - Test Plan. . . . .	.32

## INTRODUCTION

The objective of this test series was to determine if an off-the-shelf item would meet the transportation and storage requirements for the Joint Stars Remote Transportable Memory Module (RTMM) case.

## CASE DESCRIPTION

The RTMM case (Figure 1) is a sealed, reusable, aluminum case which conforms to MIL-C-4150J, Military Specification, Cases, Transit and Storage, Waterproof and Water-Vaporproof, Type I (waterproof), Style 1 (transit case), Class A (maximum gross weight up to 150 pounds), Variety HC (hinged closure).

The cushioning system initially was engineered for physical and environmental protection for up to eight RTMMs (hereafter referred to as Configuration 1). The case weighed 50 pounds with eight simulated RTMMs (hereafter referred to as RTMMs). Each RTMM weighted 4.38 pounds (Figure 2).

Upon test completion, the user requested the case gross weight be reduced. The cushioning system (hereafter referred to as Configuration 2) was re configured for up to six RTMMs.

The case is a deep drawn, 0.09 inch thick aluminum combination case with a hinged and latched cover ("clam shell" configuration). Case empty weight is 15.44 pounds. The case is equipped with one handle, four latches, two hinges, and gasketed closure with neoprene gasket. Case dimensions are 20.4 inches length, 14.8 inches width, and 10.2 inches height.

The Configuration 1 cushioning system consisted of polyurethane foam. Identical two inch flat polyurethane cushions covered the inside of the case base and cover. Two inch thick cushions with cut outs for up to four RTMMs fitted inside of the base and cover and on top of the base and cover cushions. A third two inch thick flat cushion fitted into the cover and prevented contact between the cover and base RTMMs (Figure 3).

The Configuration 2 cushioning system also consisted of polyurethane foam. A four inch thick flat polyurethane cushion covered the case cover and a two inch thick cushion covered the case base. A four inch thick cushion with cut outs for up to six RTMMs fitted inside of the base and on top of the base cushion (Figure 4).

## TEST PROCEDURE

The RTMM case was tested in accordance the Air Force Packaging Technology and Engineering Facility (AFPTEF) Test Plans, 15 Jun 94, (Appendix 3), which referenced MIL-C-4150J, MIL-STD-648A, MIL-STD-810E, and FED-STD-101C. The Test Project Number was 94-P-113.

The test methods constitute both the procedure for performing the tests and performance criteria for evaluation of case acceptability. The tests are commonly applied to special shipping cases providing rough handling protection to sensitive items. The tests were performed at AFMC-LSO/LGTP, 5215 Thurlow St, Bldg 70, Wright-Patterson AFB, OH 45433-5540.

## CASE FACE IDENTIFICATION

The correlation between numbered and designated case sides was as follows (Figure 5 and 6).

<u>NUMBERED</u> <u>SIDE</u>	<u>DESIGNATED</u> <u>SIDE</u>
1	Top
2	Forward (Handle)
3	Bottom
4	AFT (Hinges)
5	Left
6	Right

## TEST SEQUENCES - CONFIGURATION 1

### TEST SEQUENCE 1 - MIL-C-4150J, 4.5.3, Examination of Product.

The case was examined to determine conformance with the material, workmanship, and requirements as specified in Table II of MIL-C-4150J. Major Category 103 was not checked. Major Categories 110, 117, 118, 119, 120 were not required. Minor Categories 204, 205, 206, 207, 208, and 209 were not required. The case passed all the other major or minor categories listed, except the following.

Major Category 106 - The clasps were not recessed within the maximum envelope of the case as required in Paragraph 3.4.4.

Major Category 109 - The stacking width is offset 0.75 inch between containers.

Major Category 111 - The pressure relief valve was not recessed on the case.

Major Category 115 - The one handle load limit (35 pounds) in Paragraph 3.4.1.1, was exceeded by 15 pounds. The handle was not recessed within the maximum envelope of the case as required in Paragraph 3.4.5.

**TEST SEQUENCE 2** - MIL-C-4150J, 4.5.4, Quality Conformance Tests and 4.6.3.6, Weight Test.

The following equipment and instrumentation was utilized:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>MODEL</u>	<u>SERIAL NUMBER</u>	<u>CALIBRATION EXPIRATION</u>
Scale	Howe		A057229	22Jul94
Scale	Circuits & Systems	BX-100	5992A	May95

The case loaded with eight RTMMs weighted 50 pounds. Each RTMM unit weighted 4.38 pounds. Thus, the case and its suspension system weighted 15.44 pounds.

#### **PERFORMANCE TESTS - CONFIGURATION 1**

**TEST SEQUENCE 3** - MIL-C-4150J, 4.6.3.1, Reusability.

The case was opened and closed five times to demonstrate reusability without degradation. The cam over center latches on the handle side were hard to close. The center cushion could be pinched in the gasket due to its thickness. These conditions did not affect the reusability of the container.

**TEST SEQUENCE 4** - MIL-C-4150J, 4.6.3.2.1, Leak Test (Submersion), FED-STD-101C, Method 5009.3, Leaks in Containers.

The following equipment and instrumentation was utilized:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>
Water Tank	AFPTEF

The case containing the RTMMs was submerged so that the uppermost surface was beneath the water surface not less than one inch or more than two inches for one hour (Figure 7). The case was dried off before opening. When opened, the case interior did not show any evidence of leakage. The leak tests were conducted in

accordance with FED-STD-101C, Method 5009.3, at ambient temperature and pressure.

**TEST SEQUENCE 5** - MIL-C-4150J, 4.6.3.3, Concentrated Load Test, FED-STD-101C, Method 5016.1, Superimposed-Load Test (Stackability, With Dunnage).

The following equipment was utilized:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>MODEL</u>	<u>SERIAL NUMBER</u>
Forklift Truck 4000 pounds	Mercury	401P	147976

The test was conducted in accordance with FED-STD-101C, Method 5016.1, with the constant "S" = 1.5, (Level B packing) for the equation of Paragraph 6.1.

The case containing the RTMMs was placed on a flat, level, rigid surface. Dunnage could not be placed on top of the case, so a 1365 pound load was applied directly on to the case cover (Figure 8).

The load remained in place for one hour. A visual inspection of the container was made when the load was removed. No container deformation was noted.

**TEST SEQUENCE 6** - MIL-C-4150J, 4.6.3.2.1, Leak Test (Submersion), FED-STD-101C, Method 5009.3, Leaks in Containers.

Reference Test Sequence 4 (Initial test description).

Moisture was noted on an edge of the center cushion (Side 2, Corner 125 latch). This condition was attributed to the cushion being trapped in the gasket. The cushion may need to be chamfered on the edges to alleviate this situation.

**TEST SEQUENCE 7A** - MIL-C-4150J, 4.6.3.8, Vibration Test,  
MIL-STD-648A, 5.3.2, Resonance Strength and  
Dwell Test.

The following equipment and instrumentation was utilized:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>MODEL</u>	<u>SERIAL NUMBER</u>	<u>CALIBRATION EXPIRATION</u>
Vibration Control	Data Physics Corp	DP540	Ver 1.22 7 CH, DWL	N/A
Vibration Machine	LAB	41012432	89003	N/A
Vibration Controller	LAB	8830	88307	N/A
Vibration Meter	LAB	487A02	0068	10 Sep 94
Low Pass Signal Filter	Krohn-Hite	3343	1943	N/A
Charge Amplifier	Endevco	2740BT	FY26	01 Aug 94
Charge Amplifier	Endevco	2740BT	FY44	08 Sep 94
Charge Amplifier	Endevco	2740BT	FY66	01 Dec 94
Container Accelerometer	Endevco	2223D	FE09	28 Oct 94

A RTMM unit (Corner 345) was instrumented with a piezoelectric triaxial accelerometer (Figures 5 and 9). Accelerometer positive axis orientations were as follows:

X Axis - Directed through case Side 2.  
Y Axis - Directed through case Side 6.  
Z Axis - Directed through case Side 1.

The continuous acceleration output was monitored to determine the maximum acceleration sustained by the case. All signals were electronically filtered using a two pole Butterworth filter with a 600 Hz cutoff frequency.

The case containing the RTMMs was rigidly attached to the vibration platform (Figure 10). A sinusoidal vibration excitation was applied in the vertical direction and cyclically swept for 7.5 minutes at 2 minutes per octave to locate the

resonant frequency. Input vibration from 5 to 12.5 Hz was at 0.125 inch double amplitude. Input vibration from 12.5 to 50.0 Hz was at 1.0 G (0 to peak).

The peak transmissibility values during the up and down frequency sweeps for Side 2 and Side 1 in the vertical axis were recorded. A peak transmissibility value of 3.9 was obtained when Side 1 was vertical (Appendix 2).

With Side 1 vertical, the vibration controller swept up the frequency range until the resonance frequency was reached. The controller locked onto and tracked this frequency for the 30 minute resonant dwell test. The test was conducted at ambient temperature. A visual inspection revealed no damage to the case, the cushioning system, or the RTMMs.

**TEST SEQUENCE 7B** - MIL-C-4150J, 4.6.3.8, Vibration Test,  
FED-STD-101C, Method 5019.1, Vibration  
(Repetitive Shock Test).

The following equipment and instrumentation was utilized:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>MODEL</u>	<u>SERIAL NUMBER</u>	<u>CALIBRATION EXPIRATION</u>
Vibration Control	LAB	5000-96B	56801	N/A
Charge Amplifier	Endevco	2740BT	FY26	01 Aug 94
Charge Amplifier	Endevco	2740BT	FY44	08 Sep 94
Charge Amplifier	Endevco	2740BT	FY66	01 Dec 94
Container Accelerometer	Endevco	2223D	FE09	28 Oct 94
Data Acquisition	GHI Systems	TRIAD CAT	Version 2.11a	N/A

The test was conducted in accordance with FED-STD-101C, Method 5019.1, at ambient temperature.

The case containing the RTMMs was placed on the vibration table with Side 2 in the vertical direction (Figure 11). Wood restraints were utilized that would prevent the case from sliding off the table. The case was allowed about 1/2 inch unrestricted movement in the horizontal direction from the centered position on the table.

The table frequency was increased from 0.0 Hertz (Hz) until the container left the table surface. At one inch double amplitude, a 1/16 inch thick metal bar could be slid freely between table and the case under all points of the case. Test duration was two hours. Test frequency varied from 4.6 to 4.7 Hz when readings were taken (Appendix 2). The case was unstable on the table.

Visual inspection revealed scratches on the case surface caused by protruding nail heads in the wood restraints. There was no functional damage to the case, the cushioning system, or the RTMMs.

**TEST SEQUENCE 8** - MIL-C-4150J, 4.6.3.2.1, Leak Test (Submersion), FED-STD-101C, Method 5009.3, Leaks in Containers.

Reference Test Sequence 4 (Initial test description).

No case leakage was noted.



**TEST SEQUENCE 9** - MIL-C-4150J, 4.6.3.5.1, Free-fall Drop Tests, FED-STD-101C, Method 5007.1, Free Fall Drop Test.

The following equipment and instrumentation was utilized:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>MODEL</u>	<u>SERIAL NUMBER</u>	<u>CALIBRATION EXPIRATION</u>
Tenney Temp/Altitude Chamber	Tenney Engineering	64-ST	11,830	28 Jan 95
Charge Amplifier	Endevco	2740BT	FY26	01 Aug 94
Charge Amplifier	Endevco	2740BT	FY44	08Sep94
Charge Amplifier	Endevco	2740BT	FY66	01 Dec 94
Container Accelerometer	Endevco	2223D	FE09	28 Oct 94
Container Accelerometer	Endevco	2223D	FF67	15 Aug 95
Data Acquisition	GHI Systems	TRIAD CAT	Version 2.11a	N/A

The freefall drop tests were conducted in accordance with FED-STD-101C, Method 5007.1, Rectangular Container Procedure G. The case was dropped 19 inches (Level B protection) onto an one inch thick steel plate located in the laboratory (Figures 12 and 13).

The case containing the RTMMs was conditioned at -30° C and was dropped on Corners 145 and 236 and Sides 1 and 4. Side 1 was dropped twice due to the waveform signal being clipped. The feet on Side 4 were slightly indented into the case wall. The impacted corners were dented.

The case containing the RTMMs was conditioned at 60° C and was dropped on Corners 125 and 346 and Sides 2 and 6. The impacted corners were dented.

Data analysis revealed that there was no response on Channel 2, (accelerometer Y axis) due to a malfunctioning charge amplifier. A new charge amplifier was substituted and the high temperature drop test was repeated. No additional damage was noted.

The case was opened on its cover after the second high temperature drop test. The base RTMMs and the base cut out cushion fell onto the center cushion in the cover. The case was then opened on its base. The center cushion, cover RTMMs, and cover cut out cushion fell onto the base. The full cover and base cushions remained in the case during both openings.

The polyurethane foam base and cover cushions experienced compression set. Tearing at the corners of the cutouts was noted. The RTMMs were loose in their cushion cut outs. The edges of the simulated RTMMs cut into the cover cushion. The actual RTMMs might not have sharp edges.

**TEST SEQUENCE 10** - MIL-C-4150J, 4.6.3.2.1, Leak Test (Submersion), FED-STD-101C, Method 5009.3, Leaks in Containers.

Reference Test Sequence 4 (Initial test description).

No case leakage was noted.

**TEST SEQUENCE 11** - MIL-C-4150J, 4.6.3.7, Handling Test.

The test requires that the case be lifted clear of the floor and suspended by one handle for two minutes. Since testing required extensive handling of the case with the RTMMs, performance of this test was considered redundant.

**TEST SEQUENCE 12** - MIL-STD-810E, Method 506.3, Rain.

Procedure I, Blowing Rain, was utilized. The rainfall rate was 1.89 inch per hour, with 40 mile per hour wind, at ambient temperature. Sides 2, 5, 4, and then 6 were each exposed to the test conditions for 30 minutes (Figure 14). The purpose of the test was to determine if rain could penetrate the case gasket. No rain was found in the case.

#### **TEST SEQUENCES - CONFIGURATION 2**

**TEST SEQUENCE 2** - MIL-C-4150J, 4.5.4, Quality Conformance Tests and 4.6.3.6, Weight Test.

The following equipment and instrumentation was utilized:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>MODEL</u>	<u>SERIAL NUMBER</u>	<u>CALIBRATION EXPIRATION</u>
Scale	Howe		A057229	01 May 95

The case loaded with six RTMMs weighted 42 pounds. Each RTMM unit weighted 4.38 pounds. Thus, the case and its suspension system weighted 15.72 pounds.

## PERFORMANCE TESTS - CONFIGURATION 2

**TEST SEQUENCE 7A** - MIL-C-4150J, 4.6.3.8, Vibration Test, MIL-STD-648A, 5.3.2, Resonance Strength and Dwell Test.

Reference Test Sequence 7A (Configuration 1).

The following equipment and instrumentation was utilized in place of the equipment listed for Configuration 1. Equipment not listed was used for both tests:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>MODEL</u>	<u>SERIAL NUMBER</u>	<u>CALIBRATION EXPIRATION</u>
Charge Amplifier	Endevco	2740BT	FW10	28 Feb 95
Charge Amplifier	Endevco	2740BT	FY65	30 Nov 94
Charge Amplifier	Endevco	2740BT	FW13	28 Feb 95
Container Accelerometer	Endevco	2223D	FF67	15 Aug 95
Table Accelerometer	Endevco	2233E	AY29	01 Nov 94
Table Charge Amplifier	Endevco	2740BT	FW26	08 Feb 95

A RTMM unit (Corner 345) was instrumented with a piezoelectric triaxial accelerometer (Figures 6 and 15). Accelerometer positive axis orientations were as follows:

X Axis - Directed through case Side 2.  
Y Axis - Directed through case Side 6.  
Z Axis - Directed through case Side 1.

The peak transmissibility values during the up and down frequency sweeps for Side 2 and Side 1 in the vertical axis were recorded. A peak transmissibility value of 2.98 was obtained when Side 2 was vertical (Appendix 2). The resonance dwell was conducted with Side 2 vertical. A visual inspection revealed no damage to the case, the cushioning system, or the RTMMs.

**TEST SEQUENCE 7B - MIL-C-4150J, 4.6.3.8, Vibration Test,  
FED-STD-101C, Method 5019.1, Vibration  
(Repetitive Shock Test).**

Reference Test Sequence 7B (Configuration 1).

The following equipment and instrumentation was utilized in place of the equipment listed for Configuration 1. Equipment not listed was used for both tests:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>MODEL</u>	<u>SERIAL NUMBER</u>	<u>CALIBRATION EXPIRATION</u>
Vibration Control	Data Physics Corp	DP540	Ver 1.22 7 CH, DWL	N/A
Vibration Machine	LAB	41012432	89003	N/A
Vibration Controller	LAB	8830	88307	N/A
Low Pass Signal Filter	Krohn-Hite	3343	1943	N/A
Charge Amplifier	Endevco	2740BT	FW10	28 Feb 95
Charge Amplifier	Endevco	2740BT	FY65	30 Nov 94
Charge Amplifier	Endevco	2740BT	FW13	28 Feb 95
Container Accelerometer	Endevco	2223D	FF67	15 Aug 95
Table Accelerometer	Endevco	2233E	AY29	01 Nov 94
Table Charge Amplifier	Endevco	2740BT	FW26	08 Feb 95

The case containing the RTMMs was placed on the vibration table with Side 2 in the vertical direction (Figure 16). Wood restraints were utilized that would prevent the case from sliding off the table. The case was allowed about 1/2 inch unrestricted movement in the horizontal direction from the centered position on the table.

Test frequency varied from 4.5 to 4.7 Hz when readings were taken (Appendix 2). There was no functional damage to the case, the cushioning system, or the RTMMs.

**TEST SEQUENCE 9** - MIL-C-4150J, 4.6.3.5.1, Free-fall Drop Tests, FED-STD-101C, Method 5007.1, Free Fall Drop Test.

The following equipment and instrumentation was utilized in place of the equipment listed for Configuration 1. Equipment not listed was used for both tests:

<u>EQUIPMENT</u>	<u>MANUFACTURER</u>	<u>MODEL</u>	<u>SERIAL NUMBER</u>	<u>CALIBRATION EXPIRATION</u>
Charge Amplifier	Endevco	2740BT	FW10	28 Feb 95
Charge Amplifier	Endevco	2740BT	FY65	30 Nov 94
Charge Amplifier	Endevco	2740BT	FW13	28 Feb 95
Container Accelerometer	Endevco	2223D	FF67	15 Aug 95

The polyurethane foam base and cover cushions experienced compression set. Tearing at the corners of the cutouts was noted. The edges of the simulated RTMMs cut into the cover cushion. The actual RTMMs might not have sharp edges.

The higher than expected Resultant Peak G values were obtained at -30° C. Further research revealed that urethanes have a "Glass Transition Temperature" at about -28.9° C. The cushioning characteristics for a given thickness of material are less below this temperature. Expected Resultant Peak G values were obtained when the case was tested above this temperature (Appendix 2).

APPENDIX 1  
PHOTOGRAPHS

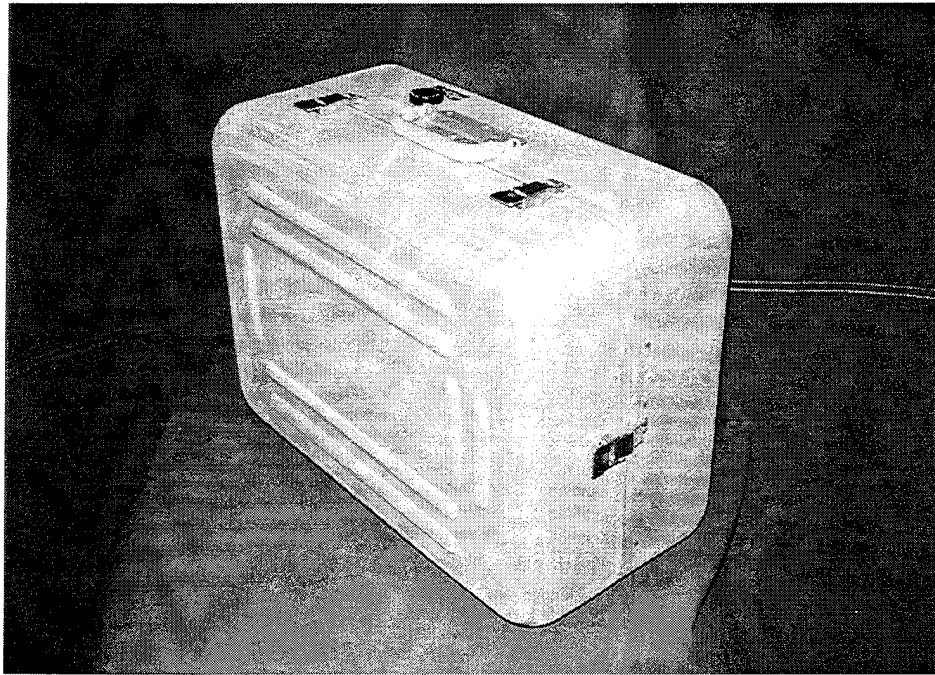


Figure 1. RTMM Case.

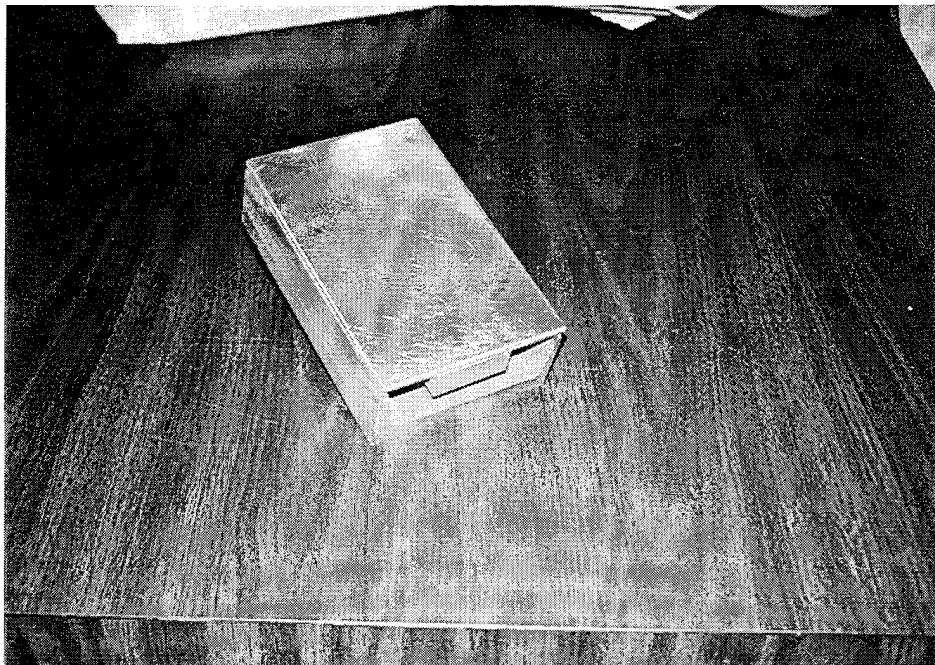


Figure 2. Simulated RTMM.



Figure 3. Configuration 1 - Case and Eight RTMMs.

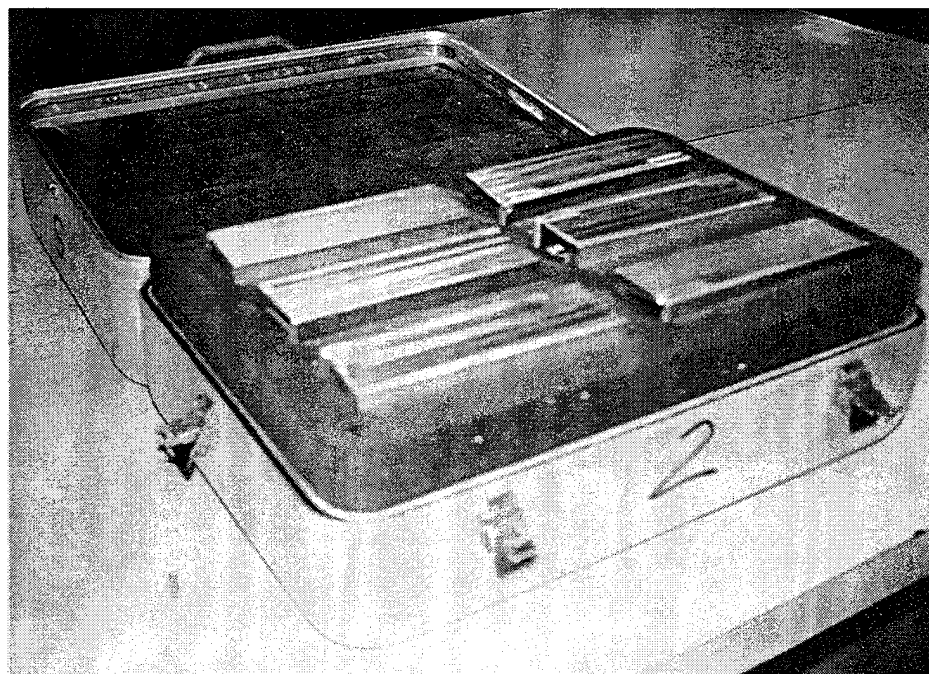


Figure 4. Configuration 2 - Case and Six RTMMs.



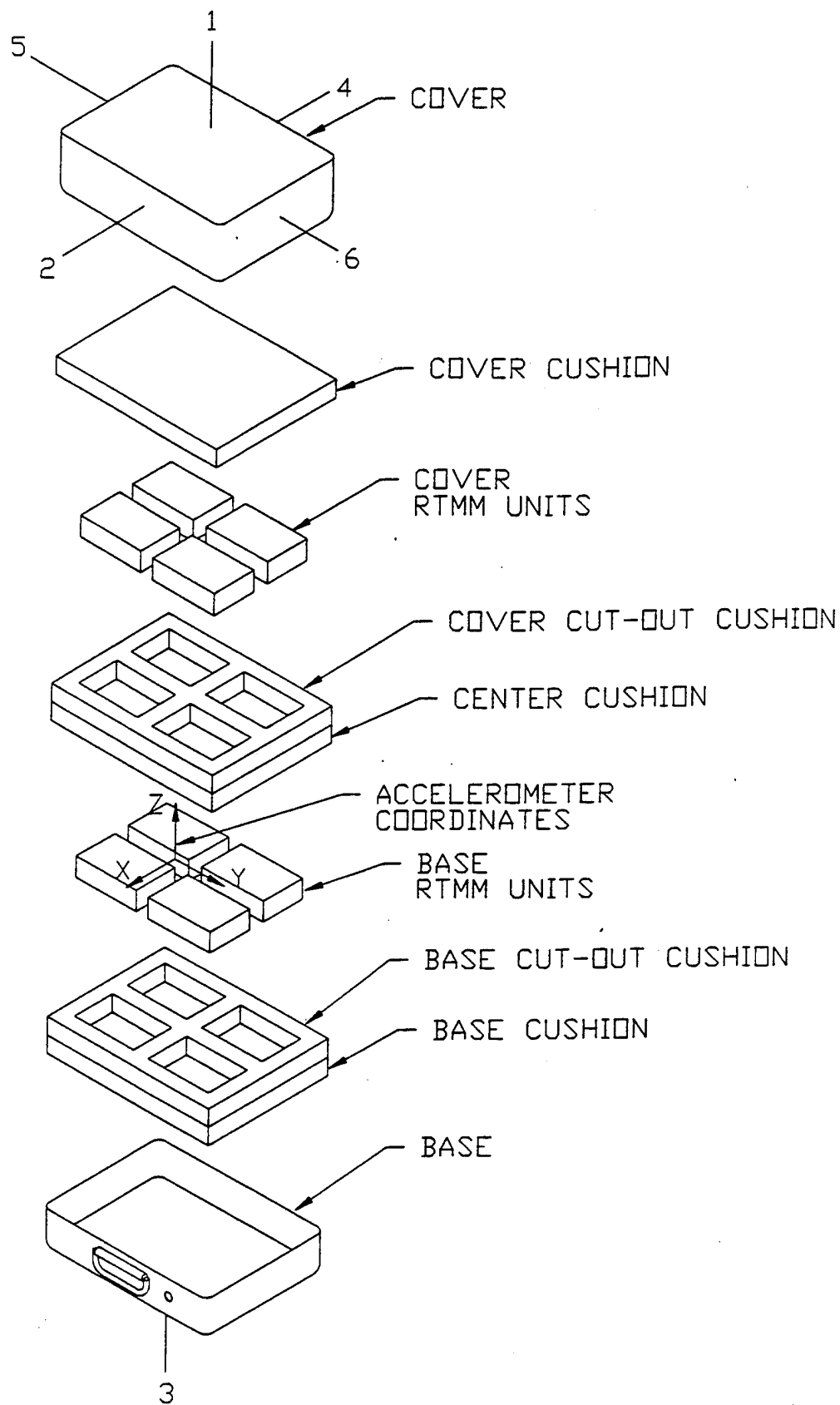


Figure 5. Configuration 1 - Case Coordinate System.

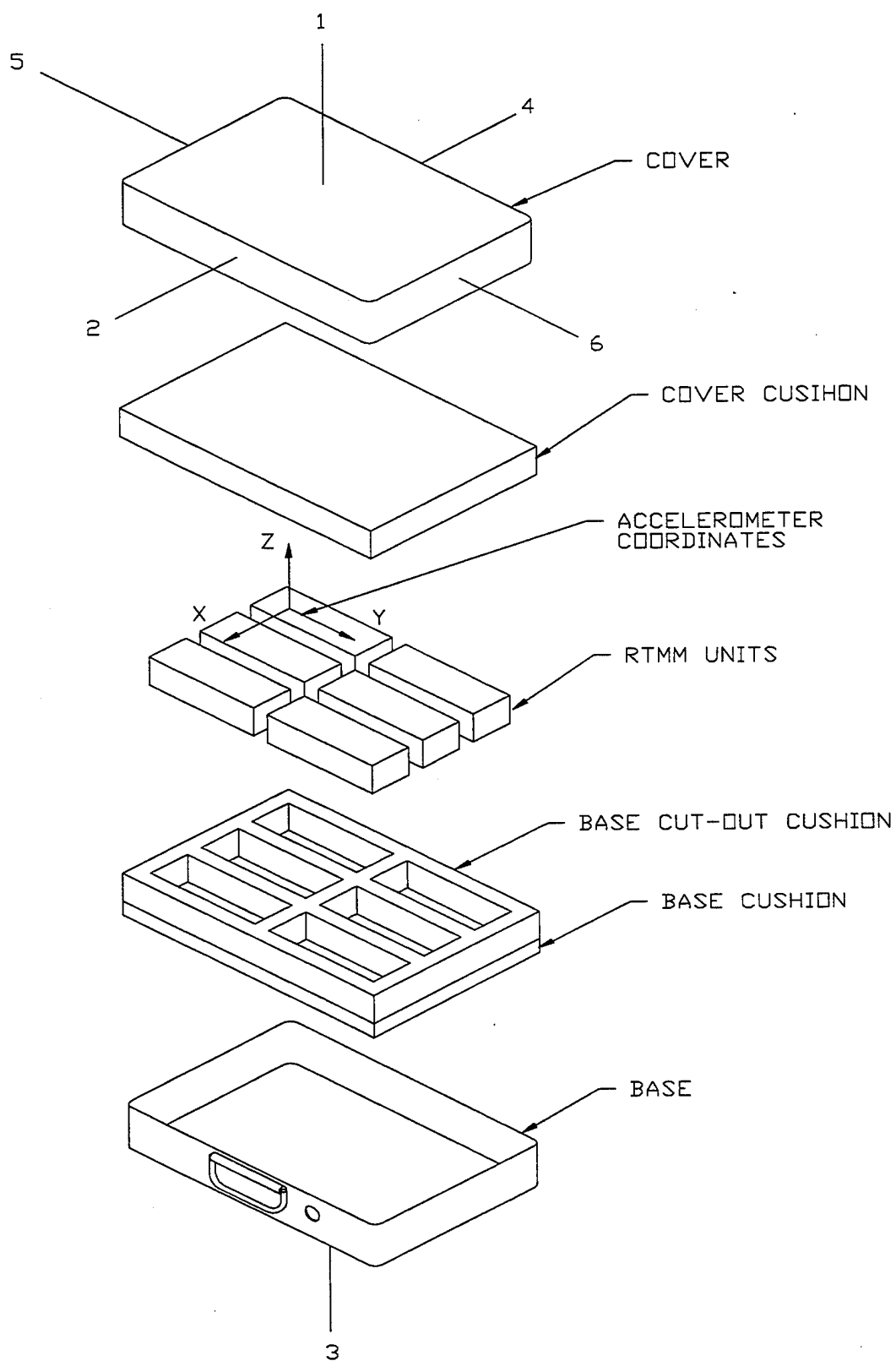


Figure 6. Configuration 2 - Case Coordinate System.

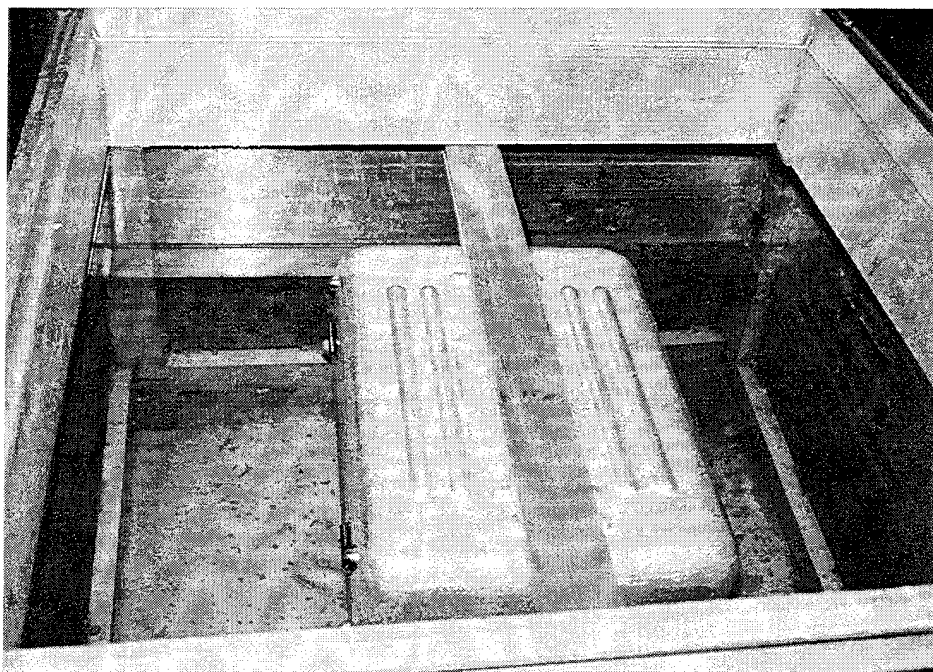


Figure 7. Leak Test (Submersion).

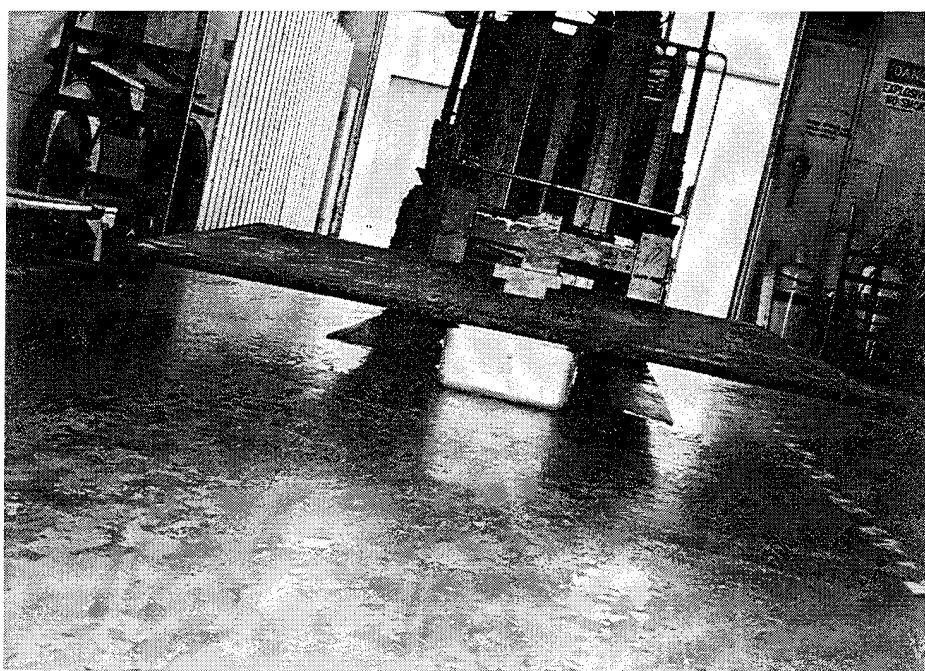


Figure 8. Concentrated Load Test.

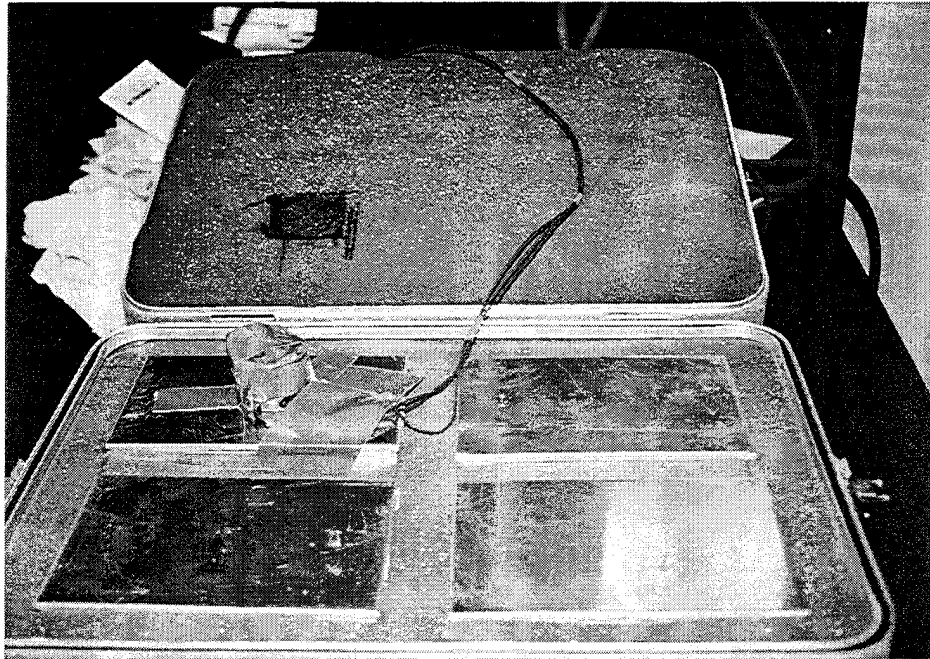


Figure 9. Configuration 1 - Accelerometer Location.

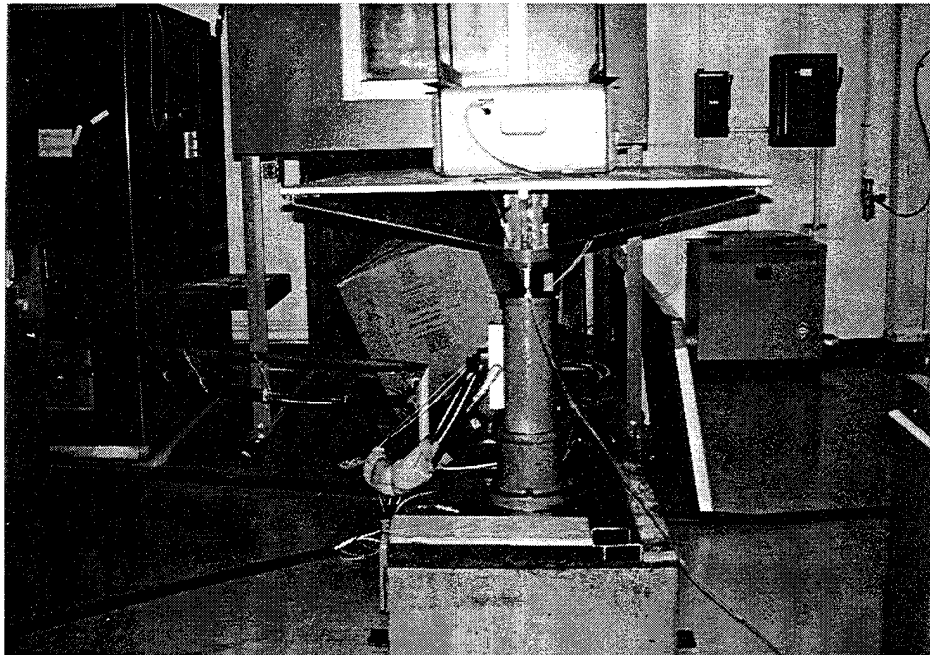


Figure 10. Resonance Strength and Dwell Test.

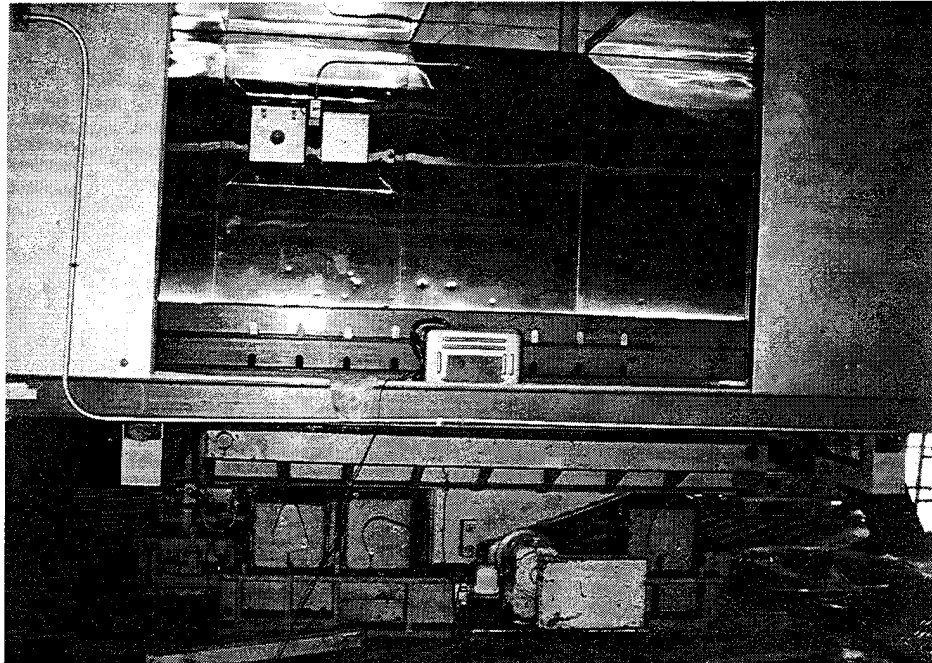


Figure 11. Configuration 1 - Repetitive Shock Test.

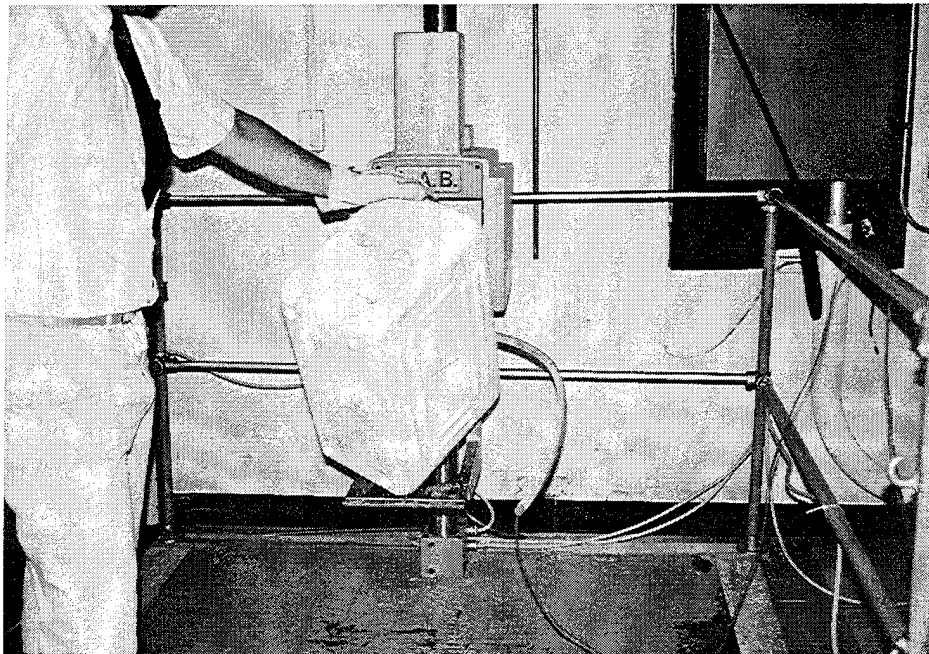


Figure 12. Cornerwise Drop Test.

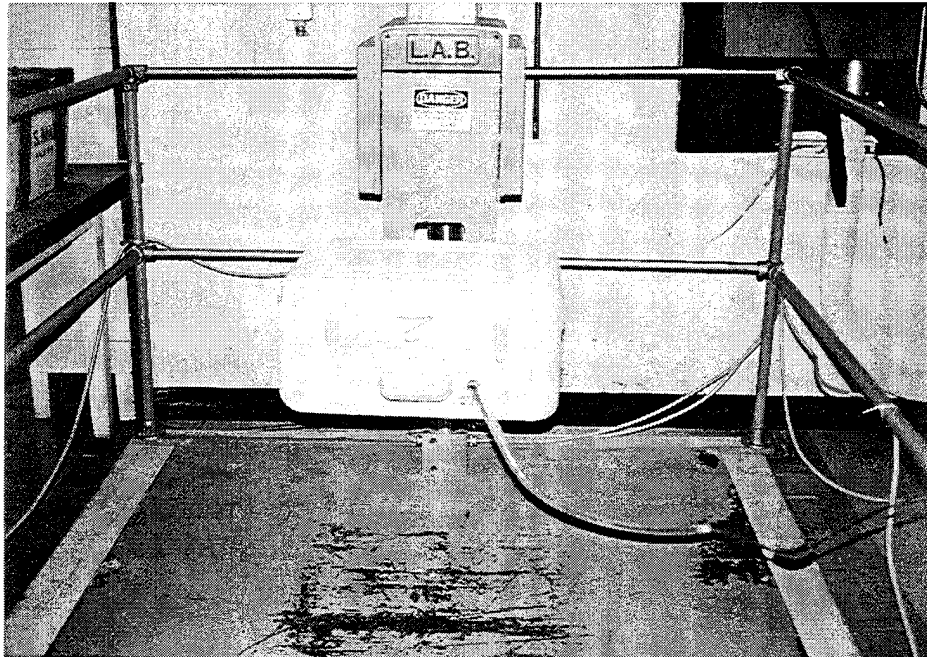


Figure 13. Flat Drop Test.

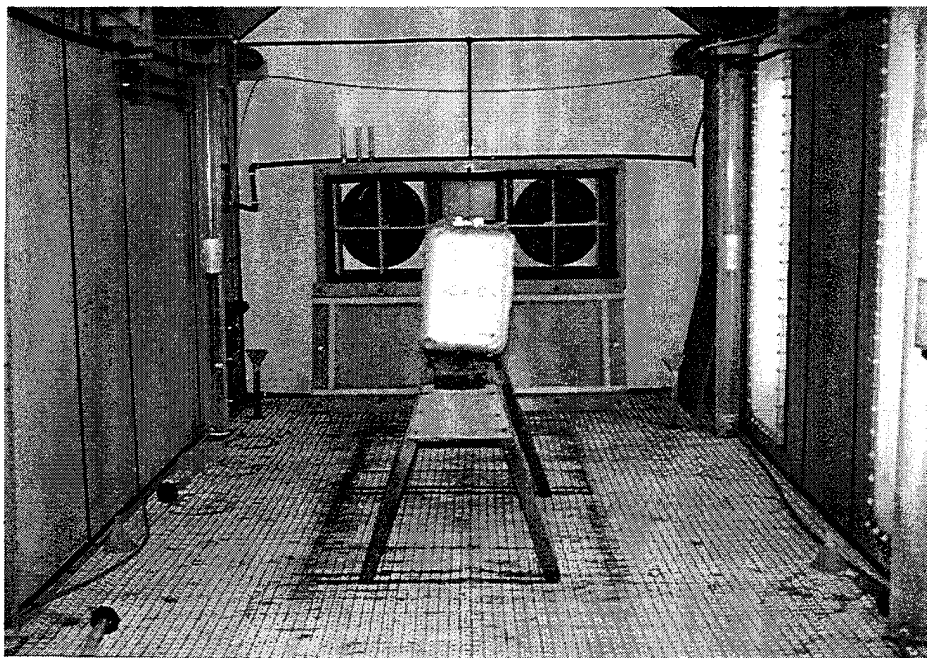


Figure 14. Rain Test.





Figure 15. Configuration 2 - Accelerometer Location.

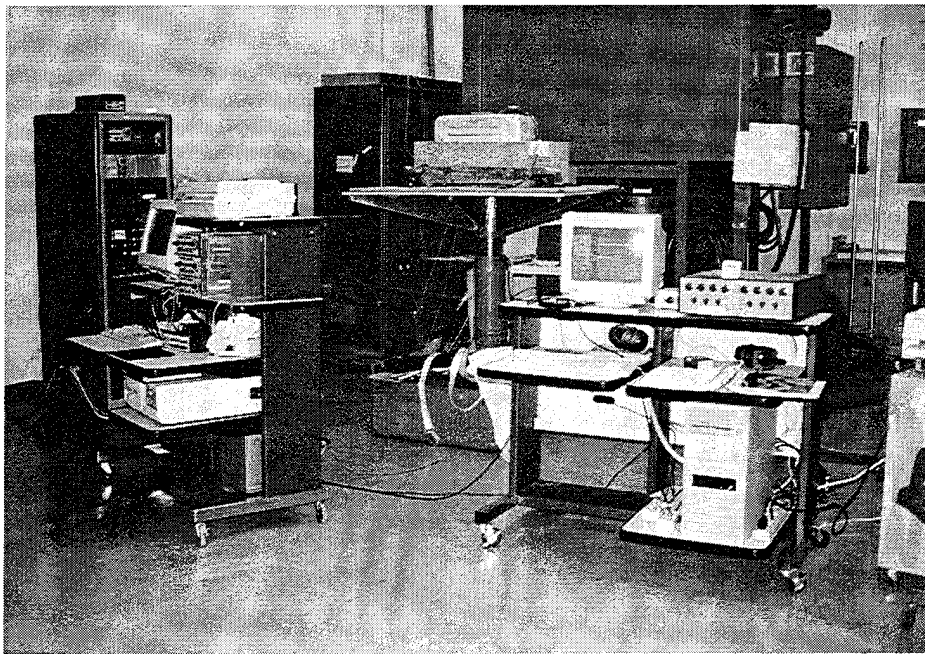


Figure 16. Configuration 2 - Repetitive Shock Test.

## APPENDIX 2

### TEST DATA



TRANSMISSIBILITY  
VIBRATION RESONANCE SEARCH AND DWELL  
CONFIGURATION 1

<u>VERTICAL</u> <u>SIDE</u>	<u>SWEEP</u> <u>DIRECTION</u>	<u>PEAK</u> <u>TRANSMISSIBILITY</u> <u>(Gs)</u>
1	UP	3.70
1	DOWN	3.60
2	UP	3.96
2	DOWN	3.90

RESULTANT PEAK G AMPLITUDE VALUES  
VIBRATION REPETITIVE SHOCK TEST

<u>TIME</u> <u>(MINUTES)</u>	<u>FREQUENCY</u> <u>(HZ)</u>	<u>PEAK</u> <u>Gs</u>
15	4.6	4.48
60	4.7	1.95
105	4.7	0.98

RESULTANT PEAK G AMPLITUDE VALUES  
FREE FALL DROP TEST

<u>TEMPERATURE</u> <u>°C</u>	<u>IMPACT</u> <u>LOCATION</u>	<u>PEAK</u> <u>(Gs)</u>
-30	145	53.18
-30	236	36.76
-30	4	43.51
-30	1	38.21
+60	125	20.72
+60	346	17.50
+60	2	30.48
+60	6	19.94

TRANSMISSIBILITY  
VIBRATION RESONANCE SEARCH AND DWELL  
CONFIGURATION 2

<u>VERTICAL SIDE</u>	<u>SWEEP DIRECTION</u>	<u>PEAK TRANSMISSIBILITY (Gs)</u>
1	UP	2.36
1	DOWN	2.34
2	UP	2.95
2	DOWN	2.98

RESULTANT PEAK G AMPLITUDE VALUES  
VIBRATION REPETITIVE SHOCK TEST

<u>TIME (MINUTES)</u>	<u>FREQUENCY (HZ)</u>	<u>PEAK Gs</u>
05	4.7	2.28
115	4.7	2.26

RESULTANT PEAK G AMPLITUDE VALUES  
FREE FALL DROP TEST

<u>TEMPERATURE °C</u>	<u>IMPACT LOCATION</u>	<u>PEAK (Gs)</u>
-30	145	66.73
-30	236	37.49
-30	4	53.61
-30	1	69.05
+60	125	*
+60	346	31.53
+60	2	28.12
+60	6	26.97
-15	145	39.56
-15	236	25.30
-15	1	48.08
-15	4	40.48

\*Data Acquisition System Hard Disk Failure, Data Not Captured.

APPENDIX 3

TEST PLAN

# AIR FORCE PACKAGING EVALUATION ACTIVITY (Container Test Plan)

AFPEA PROJECT NUMBER:

93-P-108

CONTAINER SIZE (L x W x D) (MILLIMETERS)		WEIGHT (Kgs)		CUBE (CU. M)	QUANTITY:	DATE:
INTERIOR:	EXTERIOR:	GROSS:	ITEM:			
515 x 372 x 254	519 x 376 x 258	22.7	18.1	0.049	1	15 JUN 94

ITEM NAME:

Removable Transportable Memory Module (RTMM)

MANUFACTURER:

Zero Corporation

CONTAINER NAME:

Transit and Storage Case

CONTAINER COST:

\$350.00 ea.

PACK DESCRIPTION:

Eight RTMM's pack in two rows of four. Two-pound polyurathane cushioning.

CONDITIONING:

As noted below

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRUMENTATION
1.	<u>Examination of Product.</u> MIL-C-4150 Para. 4.5.3 Table II	Each case shall be carefully examined to determine conformance with material, workmanship, and requirements as specified in Table II of MIL-C-4150.	Ambient temp.	Visual Inspection (VI)
2.	<u>Quality Conformance Tests.</u> <u>Weight Test.</u> MIL-C-4150 Para. 4.5.4 Para. 4.6.3.6	Each case shall be weighted.	Ambient temp.	Scale
	<u>Performance Tests.</u>			
3.	<u>Reusability.</u> MIL-C-4150 Para. 4.6.3.1	The case shall be opened and closed five times to demonstrate reusability without degradation. Ease of operation and freedom from interference shall constitute acceptance.	Ambient temp.	VI
4.	<u>Submersion Test.</u> MIL-C-4150 Para. 4.6.3.2 FED-STD-101 Method 5009	Case shall be submerged under 25 - 50 mm of water for one hour. Case shall show no signs of water penetration.	Ambient temp.	VI

COMMENTS:

PREPARED BY:

Robert S. Tekesky, Mechanical Engineer

APPROVED BY:

Ted Hinds, Chief, Design Group, AFPEA

# AIR FORCE PACKAGING EVALUATION ACTIVITY (Container Test Plan)

AFPEA PROJECT NUMBER:

93-P-108

CONTAINER SIZE (L x W x D) (MILLIMETERS)		WEIGHT (Kgs)		CUBE (CU. M)	QUANTITY:	DATE:
INTERIOR:	EXTERIOR:	GROSS:	ITEM:			
515 x 372 x 254	519 x 376 x 258	22.7	18.1	0.049	1	15 JUN 94

ITEM NAME:  
Removable Transportable Memory Module (RTMM)

MANUFACTURER:  
Zero Corporation

CONTAINER NAME:  
Transit and Storage Case

CONTAINER COST:  
\$350.00 ea.

PACK DESCRIPTION:  
Eight RTMM's pack in two rows of four. Two-pound polyurathane cushioning.

CONDITIONING:  
As noted below

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRUMENTATION
5.	<u>Concentrated Load Test.</u> MIL-C-4150 Para. 4.6.3.3 FED-STD-101 Method 5016	Prescribed load (W) shall be applied to the top of the case, in a manner simulating the stacking of similar cases. This load shall remain for a minimum of one hour. W = 1365 lbs.	Ambient temp. on a flat, level, rigid floor.	VI Measure any height changes
6.	<u>Submersion Test.</u> MIL-C-4150 Para. 4.6.3.2 FED-STD-101 Method 5009	Case shall be submerged under 25 - 50 mm of water for one hour. Case shall show no signs of water penetration.	Ambient temp.	VI
7.	<u>Vibration Test.</u>			
a.	MIL-C-4150 Para. 4.6.3.8 MIL-STD-648 Para. 5.3.2	The case shall be vibrated from 5 hz to 50 hz at a sweep rate of one half octave per minute with a total sweep time of 7.5 minutes. Case shall then be vibrated for 30 minutes at the predominant resonance.	Ambient temp. Accelerometer located in back, bottom, lefthand side of case. Normal shipping position.	VI Tri-axial accelerometer to measure G-forces
b.	MIL-C-4150 Para. 4.6.3.8 FED-STD-101 Method 5019	The case shall be vibrated IAW FED-STD-101, Method 5019 for not less than two hours.	Ambient temp. Accelerometer located in back, bottom, lefthand side of case. Normal shipping position.	VI Tri-axial accelerometer to measure G-forces

COMMENTS:

PREPARED BY:  
Robert S. Tekesky, Mechanical Engineer

APPROVED BY:  
Ted Hinds, Chief, Design Group, AFPEA

# AIR FORCE PACKAGING EVALUATION ACTIVITY (Container Test Plan)

AFPEA PROJECT NUMBER:

93-P-108

CONTAINER SIZE (L x W x D) (MILLIMETERS)		WEIGHT (Kgs)		CUBE (CU. M)	QUANTITY:	DATE:
INTERIOR:	EXTERIOR:	GROSS:	ITEM:			
515 x 372 x 254	519 x 376 x 258	22.7	18.1	0.049	1	15 JUN 94

ITEM NAME:

Removable Transportable Memory Module (RTMM)

MANUFACTURER:

Zero Corporation

CONTAINER NAME:

Transit and Storage Case

CONTAINER COST:

\$350.00 ea.

PACK DESCRIPTION:

Eight RTMM's pack in two rows of four. Two-pound polyurathane cushioning.

CONDITIONING:

As noted below

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRUMENTATION
8.	<u>Submersion Test.</u> MIL-C-4150 Para. 4.6.3.2 FED-STD-101 Method 5009	Case shall be submerged under 25 - 50 mm of water for one hour. Case shall show no signs of water penetration.	Ambient temp.	VI
9.	<u>Free-fall Drop Tests.</u> MIL-C-4150 Para. 4.6.3.5.1 FED-STD-101 Method 5007 Level B	Each case shall be dropped on two sets of diagonally opposite corners, on the bottom, top, and two adjacent sides (8 drops). Half the drops shall be done at -30 (+0/-6) °C and the other half done at +60 (+6/-0) °C per MIL-C-4150, Para. 4.6.3.4.	Loaded Case At temperature extremes. Accelerometer located in back, bottom, lefthand side of case.	VI Tri-axial accelerometer to measure G-forces
10.	<u>Submersion Test.</u> MIL-C-4150 Para. 4.6.3.2 FED-STD-101 Method 5009	Case shall be submerged under 25 - 50 mm of water for one hour. Case shall show no signs of water penetration.	Ambient temp.	VI
11.	<u>Handling Test.</u> MIL-C-4150 Para. 4.6.3.7	The case shall be lifted clear of the floor and suspended by one handle for a minimum of two minutes.	Ambient temp.	VI

COMMENTS:

PREPARED BY:

Robert S. Tekesky, Mechanical Engineer

APPROVED BY:

Ted Hinds, Chief, Design Group, AFPEA

# AIR FORCE PACKAGING EVALUATION ACTIVITY (Container Test Plan)

AFPEA PROJECT NUMBER:

93-P-108

CONTAINER SIZE (L x W x D) (MILLIMETERS)		WEIGHT (Kgs)		CUBE (CU. M)	QUANTITY:	DATE:
INTERIOR:	EXTERIOR:	GROSS:	ITEM:			
515 x 372 x 254	519 x 376 x 258	22.7	18.1	0.049	1	15 JUN 94

ITEM NAME:  
Removable Transportable Memory Module (RTMM)

MANUFACTURER:  
Zero Corporation

CONTAINER NAME:  
Transit and Storage Case

CONTAINER COST:  
\$350.00 ea.

PACK DESCRIPTION:  
Eight RTMM's pack in two rows of four. Two-pound polyurathane cushioning.

CONDITIONING:  
As noted below

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRUMENTATION
12.	<u>Blowing Rain Tests.</u> MIL-STD-810 Method 506.2	Each case shall be tested for waterproof capabilities IAW MIL-STD-810, Method 506.2. Rain fall rate shall be 0.8 mm/min with 18 m/s winds. Test duration shall be 30 minutes on each face.	Case tested on all four faces where the cover and base interface.	VI of interior for water penetration.

COMMENTS:

PREPARED BY:  
Robert S. Tekesky, Mechanical Engineer

APPROVED BY:  
Ted Hinds, Chief, Design Group, AFPEA

# AIR FORCE PACKAGING EVALUATION ACTIVITY (Container Test Plan)

AFPEA PROJECT NUMBER:

93-P-108

CONTAINER SIZE (L x W x D) (MILLIMETERS)		WEIGHT (Kgs)		CUBE (CU. M)	QUANTITY:	DATE:
INTERIOR:	EXTERIOR:	GROSS:	ITEM:			
515 x 372 x 254	519 x 376 x 258	22.7	18.1	0.049	1	15 JUN 94

ITEM NAME: Removable Transportable Memory Module (RTMM) MANUFACTURER: Zero Corporation

CONTAINER NAME: Transit and Storage Case CONTAINER COST: \$350.00 ea.

PACK DESCRIPTION: Six RTMM's pack in two rows of three. Two-pound polyurathane cushioning.

CONDITIONING:  
As noted below

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRUMENTATION
1.	<u>Vibration Test.</u>			
a.	MIL-C-4150 Para. 4.6.3.8 MIL-STD-648 Para. 5.3.2	The case shall be vibrated from 5 hz to 50 hz at a sweep rate of one half octave per minute with a total sweep time of 7.5 minutes. Case shall then be vibrated for 30 minutes at the predominant resonance.	Ambient temp. Accelerometer located in back, bottom, lefthand side of case. Normal shipping position.	VI Tri-axial accelerometer to measure G-forces
b.	MIL-C-4150 Para. 4.6.3.8 FED-STD-101 Method 5019	The case shall be vibrated IAW FED-STD-101, Method 5019 for not less than two hours.	Ambient temp. Accelerometer located in back, bottom, lefthand side of case. Normal shipping position.	VI Tri-axial accelerometer to measure G-forces
2.	<u>Free-fall Drop Tests.</u>			
	MIL-C-4150 Para. 4.6.3.5.1 FED-STD-101 Method 5007 Level B	Each case shall be dropped on two sets of diagonally opposite corners, on the bottom, top, and two adjacent sides (8 drops). Half the drops shall be done at -30 (+0/-6) °C and the other half done at +60 (+6/-0) °C per MIL-C-4150, Para. 4.6.3.4.	Loaded Case At temperature extremes. Accelerometer located in back, bottom, lefthand side of case.	VI Tri-axial accelerometer to measure G-forces

COMMENTS:  
Item configuration was changed requiring vibration and drop test only.

PREPARED BY:  
Robert S. Tekesky, Mechanical Engineer

APPROVED BY:  
Ted Hinds, Chief, Design Group, AFPEA



APPENDIX 4  
DISTRIBUTION LIST

# DISTRIBUTION LIST

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AND CONTAINERIZATION CENTER  
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2

APPENDIX 5  
REPORT DOCUMENTATION



REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
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13. ABSTRACT (Maximum 200 words) <p>The Electronic System Center (ESC) at Hanscom AFB, MA requested the Air Force Packaging Technology and Engineering Facility (AFPTEF) assistance in designing a carrying case for the Joint STARS Program. The Joint STARS Program requires a carrying case to transport Remote Transportable Memory Modules (RTMM). The RTMM's are similar to a hard disk drive in a computer. Upon completion of a Joint STARS mission, the RTMM's are removed from the aircraft and transported to a base.</p> <p>The weight of the case and the number of RTMMs required per mission were the driving factors in the design. The case requirements are to be waterproof, one person carry, shock absorbent, house six RTMM's, and limited to a maximum weight of 42 pounds.</p> <p>After reviewing Joint STARS requirements, AFPTEF determined the best case design to be an off the shelf transit case. AFPTEF chose a water resistant, thin wall aluminum case. Case dimensions are 20.4 inches' length, 14.8 inches wide, and 10.2 inches' height. Wall thickness of 0.09 inches. The case has four cam-over-center latches, pressure relief valve, one handle, hinged top, stacking beads on the top and bottom to interlock stacked cases, and anti-static foam that houses six RTMM units. Maximum tare weight of the case is 15.5 pounds with a maximum gross weight of 42 pounds. External finish is bare aluminum.</p>				
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